AD-A150 129 SWITCHABLE ZERO ORDER DIFFRACTION GRATINGS AS LIGHT VALVES(U) MASSACHUSETTS INST OF TECH CAMBRIDGE RESEARCH LAB OF ELECTRONICS J MELNGAILIS 01 NOV 84 1/1

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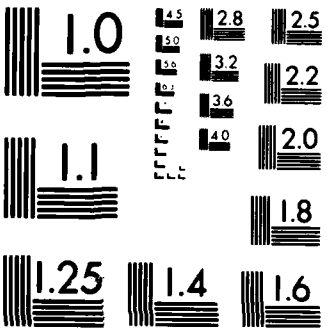

Semiannual Report

1 April 1984 to 30 September 1984

"Switchable Zero Order Diffraction Gratings as Light Valves"

Office of Naval Research

Contract N00014-84-K-0073

Submitted by

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November 1, 1984

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The aim of this project is to fabricate a light valve which operates on the principle of the cancellation of the zero order of diffraction. The light valve consists of two facing aligned phase gratings in a transparent medium. Displacing one grating with respect to the other by one-half of one grating period switches the valve from a transmitting to an absorbing state. The light valve is to be about 1-2 mm square and be mass producible into matrix addressable arrays. Arrays of this type can operate as displays or as spatial light modulators for optical signal processing.

We have chosen to fabricate the light element using polyvinilydine fluoride (PVF_2) which is a transparent piezoelectric. The gratings are embossed into the plastic and the piezoelectricity is used to produce the motion needed for switching.

Progress in the Half-Year

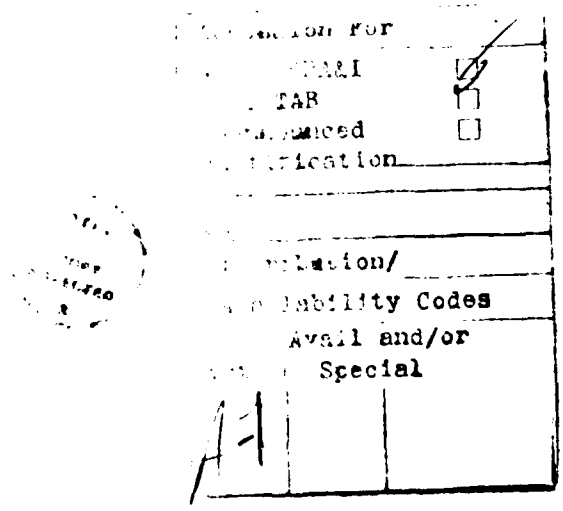
The fabrication procedures described in more detail in the previous semi-annual report have been refined and applied to the fabrication of bigrate structures. A successful embossing procedure has been developed, and the process of embossing is being studied. Some relaxation of the embossed grating takes place. In addition, in the deeper gratings the PVF_2 appears to shear just below the vertical grating sidewalls. The depth of the shear is about one micron. In fact, we speculate that some shear of the material appears to be needed in order to produce vertical sidewalls. Although gratings can now be produced for the purpose of demonstrating the light valve, we plan to study the embossing and to improve the process.

In the fabrication of the chevron patterns described in the previous report, again, some further development has occurred. The procedure is now

carried out on embossed gratings, which will be used in the light valve. These PVF_2 samples are smaller and even more difficult to handle because of curling. However, the photolithography and reactive ion etching is being carried out successfully.

Once the chevron is fabricated we need a transfer technique to put it on the sample which has the facing grating embossed on it. A technique which depends on attaching the membrane to a frame has been tried and found to work. To attach the chevron arms to a substrate microgluing and crimping were investigated. Although crimping has been found to work, and we favor that in the long run, the current chevrons were attached by glue, and the desired motion was observed, i.e., when voltage is applied to the arms of the chevron, a 1 mm square of PVF_2 are displaced two microns. This is more than enough to operate the light valve. We are now in the process of fabricating the same structure with gratings on the two faces.

Based on these results we submitted an abstract to the SPIE Symposium on "Advances in Display Technology" to be held January 20-25, 1985. The paper has been accepted for presentation and publication. A copy is attached.



A Display Based on Switchable Zero Order Diffraction Grating Light Valves[+]

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A flat panel display technology has been conceived which utilizes a matrix of line addressable light valves back lighted with a partially collimated source. The basic pixel element of the display is an optical switch based on the zero order of diffraction by two facing aligned transmission phase gratings. The transmission of light is modulated by mechanically displacing one grating with respect to the other by one-half of the grating period. The color transmitted by the light valve is controlled by the grating profile.

Optical spectra of a large-scale prototype of the switchable light valve element are in good agreement with calculations according to simple diffraction theory. Technology for the construction of an optical switch of the desired size has been developed, with 85% of the area devoted to light transmission. The elements are one millimeter squares made of polyvinylidene fluoride (PVDF), a transparent, piezoelectric plastic. Gratings of nearly square wave profile with 3.8 micron period and depths from 0.6 to 1.8 microns are produced in 9 micron films of PVDF by embossing at 4000 bars and 70°C and show the expected optical transmission spectra. Mechanical displacement is produced by applying voltage to two sets of bending arms attached to either side of the movable element. The bending arms amplify motion due to piezoelectric strain. Nickel electrodes are patterned onto the PVDF film by photolithography and liftoff. Perforations around the movable element and the bending arms are etched through the film by reactive ion etching in oxygen, using patterned aluminum as a mask. Motion exceeding 2 microns has been observed, which is sufficient to operate the light valve.

[+]This work was sponsored by Defense Advanced Research Projects Agency under Office of Naval Research Contract No. N00014-84-K-0073.

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